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DIESEL-ELECTRIC COGENERATING POWER PLANT ASSESSMENT FOR REMOTE SITE APPLICATIONS



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**OCTOBER 1986** 

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This technical report has been reviewed and is approved for publication.

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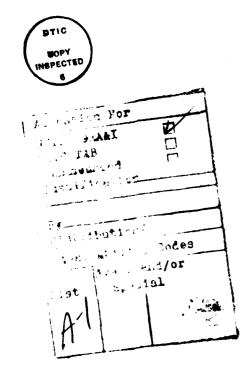
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Diesel-Electric Cogenerating Power Plant Assessment for Remote Site **Applications** 



## SUMMARY

## INTRODUCTION

This program was directed toward assessing the Life Cycle Cost (LCC) of state-of-the-art diesel-electric cogenerating power plants at Air Force remote sites. This report assesses the LCC's of present and future diesel cogenerating plants for use at the Distant Early Warning Line (DEWLine) radar sites. The LCC consists of the fuel cost, acquisition cost, and the operation and maintenance cost. These costs were evaluated in constant 1985 dollars with no escalation or depreciation over a twenty year power plant life. The electrical size of the individual plants on the DEWLine ranged from 60 to 500 kilowatts (kW). The main emphasis of this study was on the 200 kW size power plants.

## STUDY APPROACH

A set of parameters required in the assessment of each component of the life cycle cost were defined and presented.

- (A) Two types of power plant operations were defined: main sites which normally required the simultaneous operation of two diesel cogenerating plants and auxiliary sites which required only one diesel cogenerating plant operating all the time.
- (B) Two case studies using either the actual on-site electricity data from a main site, or estimated electricity consumption from an auxiliary site were presented. The space heating and hot water requirements were assumed to be at a flat, constant level for both cases. For the main site, actual acquisition costs for a set of five (5) engines in a recent (1985) project were used. The proposed labor schedule was assumed to be a two (2) man-crew working 54 hours a week and 52 weeks a year for main sites. The maintenance cost was projected from the actual FY85 average costs of main DEWLine sites equipped with older engine-generators. For the auxiliary site, actual (1985) acquisition costs for a set of 3 engines were used. Projected 0 & M costs from older engines at 4 DEWLine auxiliary sites with either 150 kW or 175 kW sets in Alaska and Canada were used to establish the life cycle cost for an auxiliary site. Life cycle costs of advanced cogenerating diesel-electric systems were also evaluated based on the projected future improvements on diesel-electric performance up to a maximum electrical generating efficiency of 50%.
- (C) One more case study with the acquisition cost based on commercially available prepackaged modules was also presented.

Social presence medicinal profession reasons

# **PREFACE**

This final technical report was prepared by the University of Dayton Research Institute under USAF Contract F33615-81-C-2011. The contract work was sponsored by the U.S. Air Force Wright Aeronautical Laboratories, Aero Propulsion Laboratory (AFWAL/P00A), Wright Patterson Air Force Base, Ohio. Mr. Steven Iden was the project manager. This report covers the period of 1 September 1985 to 31 December 1985.

The author wishes to acknowledge the generous support and technical assistance provided by Mr. S. Iden, Mr. J. Turner, and Lt J. P. Fellner of the Aerospace Power Division, Aero Propulsion Laboratory throughout the duration of this contract. Without their wise guidance, it would have been nearly impossible to sort out the many variables and remote site operating conditions to develop a clear set of important parameters required for evaluating the life cycle cost of diesel-electric cogenerating power plants at Air Force remote sites.

The author also wishes to acknowledge the generous support provided by Mr. W. E. Evans of the DEWLine Civil Engineering Office at Peterson AF8, Colorado. Volumes of operation and maintenance records of various diesel-electric cogenerating power plants were made available to the author. Through Mr. Evans' effort, a meeting with ITT FELEC Services, Incorporated was scheduled to discuss the various aspects of DEWLine power plant operations and the renovations planned for some Main and Auxiliary sites. Detailed insights were brought to discussion by Messrs R. McCuddy, C. Smith, K. Frazier, and F. Boskovich from ITT. It was very much appreciated.

Additional information provided by Captain M. Skomrock, an USAF officer on leave for full time study toward a PhD Degree in Mechanical Engineering at University of Dayton is also gratefully acknowledged.

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# COMPONENTS OF THE LIFE CYCLE COST AND VARIABLES WITHIN EACH COMPONENT

# 1-1 COSTS

All costs are evaluated in constant 1985 dollars with no escalation or depreciation over a 20 year operating period.

# 1-2 LIFE CYCLE COST (LCC)

LCC = Acquisition Cost + Fuel Cost + Operation & Maintenance (O&M) Costs

# 1-3 ACQUISITION COST

The acquisition cost consists of the following components and considerations:

Engine Cost: types, manufacturers, etc.

Heat Exchangers: types, manufacturers, etc.

Engine Module: cost of computer control system, switchgear, wiring, type of module construction, materials, labor, etc.

Total Freight: originating point, location of the site, air or sea lift, etc.

Site Preparation and Installation: location and condition of the site, man-hours required, labor rates, materials required, etc.

# 1-4 TOTAL FUEL COST OVER A 20 YEAR OPERATING PERIOD

The fuel cost consists of the following components and considerations:

Unit Cost (\$/Gallon): location of the site, heat content, etc.

Cost of Fuel for Generating Electricity: annual kilowatt-hour (kWh) consumption at the site, electrical efficiency of the diesel generating system, etc.

Cost of Fuel for Generating Heat: space heating and domestic hot water loads, monthly kWh consumption profile, amount of waste heat contained in the engine cooling water and exhaust gas, efficiency of heat exchangers, etc. The cost of the auxiliary boiler is not included in the total acquisition cost listed in 1-3.

# 1-5 TOTAL O & M COSTS OVER A 20 YEAR POWER PLANT LIFE

The 0 & M cost consists of the following components and considerations:

Total Cost of Lube Oil: location of the site, number of oil changes, etc.

Total Parts Cost: mean time between failure and established maintenance schedule, location of the site, etc.

Total Labor Cost: location and type of site

# 1-6 NUMBER OF ENGINE-GENERATORS

Two scenarios satisfy the power requirements of most of the main and auxiliary sites.

Main Sites: Five 200 kW engines; two are operating all the time, two on hot stand-by, and one on scheduled maintenance.

Auxiliary Sites: Three 200 kW engines; one operating all the time, one on hot stand-by, and one on scheduled maintenance.

# 1-7 ENGINE-GENERATOR SYSTEM PERFORMANCE, 1985 AND 1990

1985 Base Year:

DFA is assumed, at 133,500 Btu/Gal.

A 60-70% average diesel engine load is assumed.

A performance of 14 kWh/Gal is assumed, corresponding to a generating efficiency of 35.8%, which has been demonstrated in newer engine-generator systems.

## CASE STUDIES

The life cycle cost of cogenerating power plants used to produce electricity and heat consists of three components. They are (1) fuel cost (the delivered fuel cost for both the auxiliary boiler and the cogenerator), (2) acquisition cost, and (3) the operating and maintenance cost.

The acquisition cost is represented by the following items:

Total cost for engine-generators, heat exchangers, silencers, pumps, etc. Engine module (including switchgear, computer controls, etc.) Freight (sealift or airlift) Site preparation and installation

The cost of delivered arctic diesel fuel (DFA) fuel is assumed to be \$2.02 per gallon (excluding CAM-4, CAM-5, DYE-2, and DYE-3) and has a higher heating value of approximately 133,500 Btu per gallon.

Operating cost data from 26 sites (6 main and 21 auxiliary sites in Alaska and Canada) were examined and analyzed. The four sites in Greenland (DYE 1, DYE 2, DYE 3 and DYE 4) were not included in the study.

The operating and maintenance costs consists of lube oil, parts, and labor cost. The cost of delivered lube oil is approximately \$4.48 per gallon for most of the 26 sites. Since it is difficult to acquire the actual cost for parts in a life span of 20 years, an alternative method is developed to estimate the oil and part costs. It is assumed that the engine-generator sets (ranging from 60 kW to 500 kW, and from less than one year old to more than 30 years old) were at various stages of the maintenance cycle during FY 85. The average lube oil and parts cost of the four main sites is, approximately, 1.5 cents/kWh. With the new 1985 Cummins 200 kW engine-generator sets, it is assumed that the average cost of oil and parts should be less than 1.5 cents/kWh.

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Four auxiliary sites (LIZ 2, LIZ 3, POW 1, and POW 2, all located in Alaska) are equipped with either 150 kW or 175 kW diesel-generators which is close to the 200 kW size selected for this study. The average FY 85 cost of lube oil and parts for these sites was approximately 1.25 cents/kWh. The average 0 & M costs for the same four sites was established at 2.34 cents/kWh. With the new 200 kW Cummins diesel-generator system (with some advantages from economy of size), it is assumed that both lube oil, parts and labor cost will be somewhat lower than the actual FY 85 cost data previously described. Therefore, a lower figure of 1.5 cents/kWh (versus 2.34 cents/kWh) in average 0 & M costs is assumed for those auxiliary sites equipped with new 200 kW diesel-generator systems.

The labor cost associated with the operation of a main site is regulated by Air Force regulations. Four operators are required, each working 54 hours a week, 52 weeks a year. The labor rates in FY85 were established at \$41 an hour for sites located in Alaska (including overtime pay), and \$28.75 an hour for sites in Canada. With the new 200 KW Cummins replacement diesel-electric

modules currently being installed in various sites, the contractor proposed to operate with a 2-man crew by taking advantage of the modern computer control equipment. Assuming a 2-man crew, the life cycle labor cost is estimated at \$4,605,000 for Alaskan operation, and \$3,229,000 for Canadian operation.

# 2-1 MAIN SITE IN CANADA (CAM-MAIN), USING 1985 TECHNOLOGY AND COSTS

(A) Acquisition Cost (five new 1985 Cummins 200 kW units):

Total cost for engine, heat exchangers, modules (including switchgear, computer controls, etc.): \$1,160,000 Freight (sealift): \$60,000 Site preparation and installation: \$230,000

Total acquisition cost:

\$1,450,000

- (B) CAM-MAIN FY85 operation: 2,241,120 kWh (with five 150 kW units) Projected for 20 years: 44,822,400 kWh
- (C) Estimated lube oil and parts costs: \$672,000 at 1.5 cents/kWh
- (D) Estimated fuel cost based on \$2.02/Gallon and 14 kWh/Gallon demonstrated by the performance of relatively new engine-generator systems: 3,201,600 gallons, and \$6,467,000 for 20 years of operation
- (E) Summary:

Acquisition Cost: O&M Costs: Labor Costs: Fuel Cost:	\$ 1,450,000 \$ 672,000 \$ 3,229,000 \$ 6,467,000	( 6%) ( 27%)	1.5 7.2	cents/kWh cents/kWh
Life Cycle Cost:	\$11,818,000			

(F) Remarks: The higher labor cost in Alaska would raise the life cycle to \$13,194,000, or 29.4 cents/kWh in average electricity cost.

# 2-2 MAIN SITE IN CANADA (CAM-MAIN) AT VARIOUS GENERATING EFFICIENCIES UP TO A MAXIMUM OF 50%

It is assumed that the available waste heat from engine exhaust gas and cooling water is more than what is actually required for space heating and domestic hot water needs. The auxiliary boilers were never operated in FY85 in 29 of the 31 sites. As a matter of fact, considerations have been given to provide space heating for outer buildings (warehouse and garage) with the surplus waste heat. Therefore, it is assumed that the space heating and hot water requirements of these remote sites are likely at 80 to 90% of the available waste heat. The available waste heat is defined as the balance of 80% and system generating efficiency. For example, at a system generating efficiency of 35.8% (corresponding to 14 kWh per gallon of DFA), the available waste heat is estimated at 44.2% of the higher heating value of the DFA fuel.

The remaining 20% is assumed to be lost through exhaust gas, cooling water, and the inefficiency of heat exchanger and other components. In case that the available waste heat is insufficient to meet the requirement, the auxiliary boiler would have to be operated.

# (A) Assumptions:

The actual space heating and hot water requirements are a flat, constant 708 million Btu's per month or an overall thermal/electric ratio of 1.11.

A boiler efficiency of 80%.

Same acquisition cost for the more advanced diesel-generator systems (using advanced technology and computer controls) for easy comparisons.

Engine generating efficiency of 35.8% (1985), 40% (15.6 kWh/Gal), 45% (17.6 kWh/Gal), and 50% (19.6 kWh/Gal).

Acquisition cost = \$1,450,000. Lube oil & parts cost = \$672,000. Labor cost = \$3,229,000. Delivered fuel cost: \$2.02 per gallon.

All Figures in 1,000		Engine-Gener	rator Efficien	СУ
· ·	35.8%	40%	45%	50 <b>%</b>
	14kWh/Gal	15.6 kWh/Gal	17.6 kWh/Gal	19.6 kWh/Gal
Engine Fuel (Gallons)	3,202	2,865	2,546	2,292
Engine Fuel Cost	\$ 6,467	\$ 5,787	\$ 5,144	\$ 4,630
Boiler Fuel (Gallons)	0	161	480	734
Boiler fuel Cost	<b>\$</b> 0	<b>\$</b> 326	<b>\$</b> 969	\$ 1,483
Total Fuel Cost	\$ 6,467	\$ 6,113	\$ 6,113	\$ 6,113
Summary:				
Acquisition Cost	\$ 1,450(12%)	\$ 1,450(13%	) \$ 1,450	\$ 1,450
Lube Oil & Parts Cost	t \$ 672( 6%)	\$ 672( 6%	) \$ 672	\$ 672
Labor Cost	\$ 3,229(27%)	\$ 3,229(28%	\$ 3,229	\$ 3,229
Total Fuel Cost	\$ 6,467(55%)	\$ 6,113(53%	\$ 6,113	\$ 6,113
Life Cycle Cost (LCC)	\$11,818	\$11,464	\$11,464	\$11,464

As can be seen, the life cycle cost is almost independent of the dieselelectric electrical efficiency based on the assumptions made. The higher the engine-generator efficiency, the less the available waste heat for space heating. Therefore, the total amount of fuel required for providing both electricity and space heating services remains about the same when the enginegenerator efficiency is greater than 40%. The unit cost of electricity generated is summarized as follows:

System Performance:	14 kWh/Gallon	15.6+ kWh/Gallon
Acquisition Cost:	3.2 cents/kWh	3.2 cents/kWh
0 & M Costs:	1.5 cents/kWh	1.5 cents/kWh
Labor Cost:	7.2 cents/kWh	7.2 cents/kWh
Total Fuel Cost:	14.4 cents/kWh	13.6 cents/kWh
Life Cycle Cost:	26.3 cents/kWh	25.5 cents/kWh

## 2-3 AUXILIARY SITE IN ALASKA (POW-2) USING 1985 TECHNOLOGY AND COST FIGURES

(A) Acquisition Cost (based on three new 1985 Cummins 200 kW units):

Total cost for three engine-generators, heat exchangers, and modules (including switchgear, computer controls, etc.): \$690,000 Freight (sealift): \$60,000 Site preparation and installation: \$170,000

Total acquisition cost:

\$920,000

CONTRACT CONTRACT

- (B) FY 85 operation: 1,120,623 kWh (with three 175 kW units) Projected for 20 years: 22,412,460 kWh
- (C) Estimated 0 & M costs: at 1.5 cent/kWh or \$336,000
- (D) Estimated fuel cost based on \$2.02/Gallon and 14 kWh/Gallon demonstrated by the performance of relatively new engine-generator systems:

1,600,890 gallons or \$3,234,000 for 20 years of operation

(E) Summary:

Acquisition Cost: \$ 920,000 ( 20%) 4.1 cents/kWh
0 & M Costs: \$ 336,000 ( 8%) 1.5 cents/kWh
Fuel Cost: \$3,234,000 ( 72%) 14.4 cents/kWh
Total Cost: \$4,490,000 (100%) 20.0 cents/kWh

# 2-4 AUXILIARY SITE IN ALASKA (POW-2) AT VARIOUS GENERATING EFFICIENCIES UP TO A MAXIMUM OF 50%

It is assumed that the heating and hot water required for an auxiliary site is about 354 million BTU's per month. The other assumptions related to the main plants are also applicable to the auxiliary sites.

Acquisition cost = \$920,000. 0 & M cost = \$336,000. Delivered fuel cost: \$2.02 per gallon.

All Figures in 1,000		-*	Eı	ngine-Gene	rato	r Efficie	ncy	
		35.8%		40%		45%		50 <b>%</b>
	14	kWh/Gal	15.	6kWh/Gal	17.	6 kWh/Gal	19.6	kWh/Gal
Engine Fuel (Gallons)		1,601		1,432		1,273	<del></del>	1,146
Engine Fuel Cost	\$	3,234	\$	2,893	\$	2,572	\$	2,315
Boiler Fuel (Gallons)		0		80		239		366
Boiler fuel Cost	\$	0	\$	162	\$	483	\$	740
Total Fuel Cost	\$	3,234	\$	3,055	\$	3,055	\$	3,055
Summary:								
Acquisition Cost	\$	920(20%)	\$	920(21%	<b>)</b> \$	920	\$	920
0 & M Costs	\$	336(8%)	\$	336( 8%	) \$	336	\$	336
Total Fuel Cost	\$	3,234(72%)	\$	3,055(71%	<b>)</b> \$	3,055	\$	3,055
Life Cycle Cost (LCC	<b>)</b> \$	4,490	\$	4,311	\$	4,311	\$	4,311

As can be seen, the life cycle cost is almost independent of the enginegenerator system efficiency based on the assumptions made.

The unit cost of electricity generated is summarized as follows:

System Performance:	14 kWh/Gallon	15.6+ kWh/Gallon
Acquisition Cost:	4.1 cents/kWh	4.1 cents/kWh
& M Costs:	1.5 cents/kWh	1.5 cents/kWh
Total Fuel Cost:	14.4 cents/kWh	13.6 cents/kWh
_ife Cycle Cost:	20.0 cents/kWh	19.2 cents/kWh

- 2-5 AUXILIARY SITES USING ACQUISITION COST BASED ON COMMERCIALLY AVAILABLE OFF-THE-SHELF MODULES AT VARIOUS GENERATING EFFICIENCIES UP TO A MAXIMUM OF 50%
  - (A) Acquisition cost is based on \$600/kW (as estimated by the author) for the modules.

Total cost for three engine-generators, heat exchangers, and modules (including switchgear, computer controls, etc.): \$360,000

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Freight (sealift): \$60,000 Site preparation and installation: \$170,000

Total acquisition cost (about \$983 per kW): \$590,000

(B) kWh generated over a period of 20 years: 22,412,460 kWh

- (C) Estimated 0 & M costs at a ceiling of 1.5 cent/kWh: \$336,000
- (D) Estimated fuel cost based on 14 kWh/Gallon: \$3,234,000 for 20 years of operation

All Figures in 1,000		Engine-Gene	rator Efficier	icy
•	35.8%	40%	45%	50%
	14kWh/gal	15.6kWh/gal	17.6 kWh/gal	19.6 kWh/gal
Engine Fuel (Gallons)	1,601	1,432	1,273	1,146
Engine Fuel Cost	\$ 3,234	\$ 2,893	\$ 2,572	\$ 2,315
Boiler Fuel (Gallons)	0	80	239	366
Boiler fuel Cost	\$ 0	\$ 162	<b>\$</b> 483	\$ 740
Total Fuel Cost	\$ 3,234	\$ 3,055	\$ 3,055	\$ 3,055
Summary:				
Acquisition Cost	\$ 590(14%)	\$ 590(15%	<b>\$</b> 590	\$ 590
0 & M Costs	\$ 336(8%)	\$ 336(8%	) \$ 336	<b>\$</b> 336
Total Fuel Cost	\$ 3,234(78%)	\$ 3,055(77%	<b>\$ 3,055</b>	\$ 3,055
Life Cycle Cost (LCC	<b>\$ 4,160</b>	\$ 3,981	\$ 3,981	\$ 3,981

As can be seen, the life cycle cost is almost independent of the enginegenerator system efficiency based on the assumptions made.

The unit cost of electricity generated is summarized as follows:

	System Performance:	14 kWh/Gallon	15.6+ kWh/Gallon
_	Acquisition Cost:	2.6 cents/kWh	2.6 cents/kWh
	0 & M Costs:	1.5 cents/kWh	1.5 cents/kWh
	Total Fuel Cost:	14.4 cents/kWh	13.6 cents/kWh
	Life Cycle Cost:	18.5 cents/kWh	17.7 cents/kWh

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## INTERPRETATION OF THE CASE STUDIES

- 3-1 The freight and installation costs are relatively insignificant, on the order of 2.5% of the Life Cycle Cost for main sites, and 6% of the Life Cycle Cost for auxiliary sites.
- 3-2 The total fuel cost (engine and auxiliary boiler) is the dominant factor in the Life Cycle Cost. It varies from approximately one-half of the Life Cycle Cost in main sites, to approximately 80% of the Life Cycle Cost in auxiliary sites.
- 3-3 The labor cost is quite significant in main sites (at about 27-28% of the LCC, second only to the total fuel cost) due to Air Force regulations on manning.
- 3-4 The labor cost is relatively insignificant in auxiliary sites. The O&M cost (including lube oil, parts and labor) is approximately 1.5 cents/kWh.
- 3-5 The lube oil and parts cost is estimated at 1.5 cents/kWh or less for main sites.
- 3-6 The total acquisition cost can be reduced by acquiring commercially available prepackaged units instead of specially assembled modules if they can satisfy the harsh requirements for arctic operations and the unique power plant control requirements. The present criterion for DEWLine operation specifies to withstand minus 60 OF temperature and 170 mph winds. However, if the power plant is to be housed inside a protective shed, as in many of the sites at the present time, the commercially available prepackaged units should be able to perform satisfactorily. One more concern is raised on whether the commercially available computer control system can function in all of the areas to match the performance of the specially packaged Cummins system. If the commercial package can meet the control specification, then special packaging costs are not incurred and the acquisition cost will be lower. Based on discussions with representatives of several companies at the 8th World Energy Engineering Conference (October 1985 at Atlanta), the unit acquisition cost will probably be less than \$1,000/kW as compared to \$1,500/kW described in the previous section.

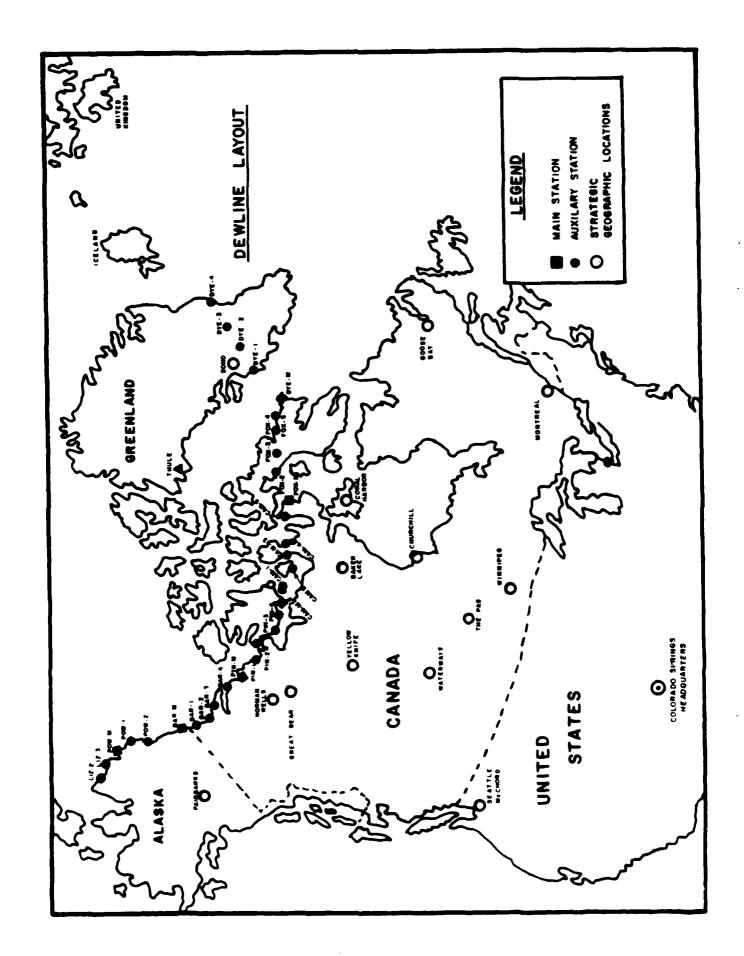
ATO DESCRIPTION OF SOME ALCOLOTO PROFITO EXECUTAN PROFESS ACCESS (FIRSTER) PARKET PROFITO

# RECOMMENDATIONS ON POTENTIAL FUTURE RESEARCH WORK BASED ON THE FINDINGS CONTAINED IN THIS REPORT

- 4-1 Actual monthly space heating, hot water, and electricity profile of several sites (Alaskan Air Command and DEWLine sites) should be solicited. The procedures outlined in Section 2 can be used to develop several actual case studies.
- 4-2 Case study of several other sites in temperate and hot climate regions can be developed.
- 4-3 Based on findings from those case studies, a generalized study can be developed to study the impact of the ratio of the thermal/electric energy needed at a site on the life cycle cost.
- 4-4 Investigate, for cost-effectiveness, how to reduce the acquisition cost through acquiring commercially available prepackaged enginegenerator modules.

# REFERENCES

- 5-1 LOCATION MAP OF DEWLINE SITES LAYOUT
- 5-2 FY85 DEWLINE POWER PLANT OPERATING COSTS STATISTICS
- 5-3 ESTIMATED MONTHLY KWH USAGE AND OTHER OPERATING STATISTICS OF SIX DEWLINE AUXILIARY POWER PLANTS: LIZ 2, POW 2, BAR 4, PIN 4, CAM 5 AND FOX 4



DENLINE PONER "LANT OPERATING COST FY85 01 Jaly 1984 Thru 30 jane 1985

SI1E	FUEL USED (USG)	FUEL	(950) 0350 110 <b>-38</b> 01	LUME OIL COST	PARTS COST	LARDR COST	Ž.	CAPITAL IMESTICHT
112-2	09626	187779.20	487	2181.76	50.78.85	7874.17	1052590	462000.00
	75855	160499.10	464	1998.08	8218.44	9017.03	982186	<b>462000.00</b>
PORTE NOT GAS NOT	20747	12628.60						
	63141	127544.82	966	4471.04	14223.28	43586.07	1487624	89e000.00
PQ+1	06026	186021.80	261	2522.24	41/57.14	17469.43	1032906	440000.00
POH-2	92125	186092.50	432	1935.36	8762.59	11306.90	1120623	200630.00
BAR-H 179KW	204246	412576.92	44 26	19962.88	28248.89	432749.11	2335373	2475000.00
*OUKIN							,	,
B#8-1	87449	176646.98	741	3319.68	18364.50	13%2.03	926776	73,000,00
BMR-2	95760		<b>908</b>	3619.84	11740.53	21640.72	867514	\$72000.00
BAR-3	107805	217766.10	879	3937.92	11364.76	17398.28	107400	369000.00
BMR-4	84945	171588.90	710	3180.80	10642.28	11004.29	877090	837000.00
PIN-M	142829	288514.58	10%	4641.28	11740.72	319384.28	1711923	66,000,00
PIN-1	86304	174334.08	716	3207.68	8425.87	12542.20	901314	611000.00
PIN-2	96857	195651.14	<b>5</b> 6	3561.60	17631.67	14399.41	799706	632000.00
PIN-3	97140	196222.80	743	3328.64	26582.82	19737.67	1080314	518000.00
PIN-4	85050	171801.00	269	3100.16	12390.04	13634.38	821126	53econ.co
CANTH	180631	384872.62	1445	6473.60	12011.27	312963.48	2241120	1305000.00
1745	90390	182587.80	27.5	¥2.00	13229.24	11756.88	222	601000.CG
CAN-2	90740	183294.80	697	3122.56	4616.90	9960.21	830896	606000.00
C##-3	106185	214493.70	823	3687.04	6005.07	14319.40	<b>205394</b>	60,000.00
	100070	256179.20	694	4032.14	29560.50	16300, 10	1011640	931000.00
COMES	10001		764	4613.14	7165.17	15791.73	990455	85000°.00
FOX-I	327917	662392.34	<b>08</b> 02	9318.40	70300.19	323421.84	4 X8 7000	2927000.00
F0X-2	86605	174942.10	<b>28</b> 0	3494.40	6258.32	12890.68	989349	<b>%</b> 1000.00
FQ-3	97540	249702.40	842	4692.02	15477.87	12563.16	2881	935000.00
FOX-4	107895	217947.90	755	3382.40	8900.03	20420.66	1057410	79,3000,00
	84 585	170861.70	<b>%</b>	¥31.68	16621.02	18006.52	994310	676000.00
DYE-M U/C	163310	370286.20	1300	5376.00	40093.25	335879.27	2299100	1731000.00
_	97554	197059.08	916	2311.68	1701.65	7055.17	767135	361000.00
DVE-1	244067	492015.24	1879	8417.92	100942.20	119282.66	2853430	36600.00
01£-2	232949	694188.02	25%	14850.36	142417.45	129117.12	2616900	302000.00
OYE-3	238514	27.17.01.	2337	13577.97	35968.90	132116.00	2521950	30,000.00
DVE-4	303387	612841.74	3126	14004.48	99294.15	129117.12	3623200	510000.00
TOTAL BA-BS NOT CAS MOS	74702	12628.60						
	4190405		36585	173426.75	828535.56	2585591.09	47331469	25879850.00
TOTAL 83-84 NAT CAS NOT	28682	15154.74						
	4525256	10580921.98	39010	181262.73	596411.56	2445565.64	21696264	16960000.00

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# FY 85 DIMILINE AUXILIANY PLANTS

The monthly Kwh usayo are ostimated as per DL Porm 258 Instruction Item 2A

Mail CAL KWH/G KWH CAL K	RABI   CAL   KAHI/G   KMH   CAL   KMHI/G   KMHI   CAL   KMHI/G		3 x 150	3		3 x 175	S KW		5 x 60	3		PIN 4 5 X 60	₹		S X S	2	FOX 4 SX60m
66800         7495         11.6         81840         8340         9.8         72692         6840         10.6         59700         6055         9.9         78790           86400         7855         10.7         83328         7390         11.3         71472         760         9.1         62992         5815         10.8         83700           86400         7875         11.0         83135         7410         11.2         68400         750         9.1         6870         7620         9.9         83220           91760         7875         11.0         8130         11.4         61572         6795         9.1         7560         7620         9.9         83220           96250         7640         12.6         9700         7460         13.2         8670         690         1.6         83519         7750         10.8         8564           9160         7470         12.1         100440         7580         13.7         6800         9.1         81874         9540           79200         745         12.1         89720         7580         12.8         7560         11.5         81376         8978         8978           79200 <th>86800         7495         11.6         81840         8340         9.8         72692         6840         10.6         59970         6055         9.9         76790           864300         7852         10.7         83128         7390         11.3         74472         760         9.3         65992         5815         10.6         83700           86400         7875         11.0         8130         11.2         66400         9.4         61312         7752         11.1         80060           96250         7640         13.5         11.0         6150         9.4         61313         7752         6795         9.1         7500         9.8         8220           98460         8455         11.0         6700         13.2         6797         9.4         61313         77128         800         10.8         8280           98460         8455         11.0         6900         12.6         81319         7751         10.8         8474         9120         760         10.9         9.4         81323         757         10.9         9.3         8484         91860         9.8         93487         94080         820113.0         9350         8690         <td< th=""><th></th><th>N. S. S.</th><th>G.</th><th>KWH/G</th><th><b>THU</b></th><th>3</th><th>KW1/G</th><th>EM.</th><th>SE</th><th>KMI/G</th><th>KMI</th><th>3</th><th>KME/C</th><th>H</th><th></th><th>#62</th></td<></th>	86800         7495         11.6         81840         8340         9.8         72692         6840         10.6         59970         6055         9.9         76790           864300         7852         10.7         83128         7390         11.3         74472         760         9.3         65992         5815         10.6         83700           86400         7875         11.0         8130         11.2         66400         9.4         61312         7752         11.1         80060           96250         7640         13.5         11.0         6150         9.4         61313         7752         6795         9.1         7500         9.8         8220           98460         8455         11.0         6700         13.2         6797         9.4         61313         77128         800         10.8         8280           98460         8455         11.0         6900         12.6         81319         7751         10.8         8474         9120         760         10.9         9.4         81323         757         10.9         9.3         8484         91860         9.8         93487         94080         820113.0         9350         8690 <td< th=""><th></th><th>N. S. S.</th><th>G.</th><th>KWH/G</th><th><b>THU</b></th><th>3</th><th>KW1/G</th><th>EM.</th><th>SE</th><th>KMI/G</th><th>KMI</th><th>3</th><th>KME/C</th><th>H</th><th></th><th>#62</th></td<>		N. S.	G.	KWH/G	<b>THU</b>	3	KW1/G	EM.	SE	KMI/G	KMI	3	KME/C	H		#62
84120 7850 10.7 83128 7390 11.3 71472 7670 9.3 62992 5635 10.8 83700 84320 7875 11.0 83135 7410 11.2 66400 7300 9.4 61381 7840 7.8 78552 91760 7375 11.4 93000 8130 11.4 61572 6795 9.1 75600 7620 9.9 83220 94660 8455 11.6 100440 7600 13.2 86970 6900 12.6 83519 7750 10.8 85544 95460 12.6 97000 7460 13.0 71060 7650 12.6 83519 7750 10.8 85544 95460 7745 12.3 100440 7350 13.7 65800 760 11.6 77200 7890 11.3 8474 95480 7745 12.3 100440 7350 13.7 65800 7860 11.6 67200 7090 9.5 83570 7750 10.1 97200 7891 10.1 97200 7891 10.1 97200 7891 10.2 90000 7410 12.1 66960 7190 9.3 86136 6160 14.0 76840 12.1 66960 7345 11.8 99720 7550 13.0 7550 13.0 86900 7345 11.8 99720 7550 13.0 7550 13.0 7550 13.0 7550 13.0 7550 13.0 86900 7345 11.8 99720 7550 13.0 7550	86400 7875 11.0 81328 7390 11.3 71472 7670 9.3 62992 5935 10.8 87700 81430 7875 11.0 81315 7410 11.2 68400 7300 9.4 61381 7840 7.8 78552 91560 7775 11.0 81315 7410 11.2 68400 7660 9.4 61381 7750 10.8 80750 9625 7640 12:6 97000 7460 13.2 86970 6900 12.6 81519 7750 10.8 85644 95480 7745 12.3 100440 7585 13.2 86970 6900 11.6 81519 7750 10.8 85644 95480 7745 12.3 100440 7350 13.7 65800 5600 11.5 91512 8080 11.3 86970 9.5 83570 7950 7745 12.3 100440 7350 12.8 75600 11.5 91512 8080 11.3 86970 9.5 83570 79500 7745 12.3 100440 7350 12.8 75600 7190 9.5 86446 6815 12.7 82478 7751 10.2 90000 7410 12.1 66960 7190 9.3 86136 6150 14.0 76840 10.2 90000 7410 12.1 66960 7190 9.3 86136 6150 14.0 76840 10.3 9000 7410 12.1 66960 7190 9.3 86136 6150 14.0 76840 10.3 90000 7410 12.1 66960 7190 9.3 86136 6150 14.0 76840 10.3 90000 7410 12.1 66960 7190 9.3 86136 6150 14.0 76840 10.3 9125 CAL 11.3 WMI/C 12.2 WMI/C 12.2 WMI/C 12.2 WMI/C 12.3 WMI/C 13.3 WMI/C	35	00898	7495	ı	81840	8340	9.6	72692	0189	10.6	59760	5009	6.6	76790		84770
86400 7875 11.0 83135 7410 11.2 66460 7300 9.4 61361 7840 7.8 78552 91760 7375 12.4 93000 8130 11.4 61572 6795 9.1 75600 7620 9.9 83220 96250 7640 12:6 97000 7460 13.0 71860 7660 9.4 83823 7575 11.1 80760 96250 7640 12:6 97000 7460 13.0 71860 7660 9.4 83823 7575 11.1 80760 96250 7640 12:6 97000 7460 13.0 71860 7660 9.4 83823 7575 11.1 80760 96250 7640 12:6 97000 7460 13.2 86770 6900 12.6 83519 7750 10.8 85684 91760 7470 12.3 100440 7585 13.2 82774 7215 11.5 77128 7855 9.8 93487 95460 7745 12.3 100440 7350 13.7 65800 5660 11.6 67200 7090 9.5 83570 79200 7810 10.1 97200 7580 12.8 75600 7840 9.6 85642 6370 13.4 80500 79200 7745 12.3 100440 7350 13.7 65800 5660 11.6 67200 7090 9.5 83570 1052590 RMH 1120623 RMH 877090 RMH 921129 RMH 921129 RMH 921129 RMH 1120623 RMH 877090 RMH 921129 RMH 921129 RMH 921129 RMH 921129 RMH 921129 RMH 921129 RMH 92125 RMH 926026 81730 13.4 86750 GAL 11.3 RMH/C 12.2 RMH/C 10.3	86400 7875 11.0 83135 7410 11.2 60400 7300 9.4 61381 7840 7.8 78552 91760 7375 12.4 93000 8130 11.4 61572 6795 9.1 75600 7620 9.9 81220 96250 7640 12:6 97000 7460 13.0 71860 7660 9.4 83823 7575 11.1 80760 96250 7640 12:6 97000 7460 13.0 71860 756 9.4 83823 7575 11.1 80760 96250 7640 12:6 97000 7460 13.2 86970 6990 12.6 83519 7750 10.8 85684 91760 7470 12.3 100440 7585 13.2 82774 7215 11.5 77128 7855 9.8 93487 76160 8165 9.3 94080 8220 11.4 81390 7060 11.5 91512 8080 11.3 84874 95480 7745 12.3 100440 7350 13.7 65800 5660 11.6 67200 7090 9.5 83570 79200 7810 10.1 97200 7580 12.8 75600 7840 9.6 85642 6370 13.4 80500 79200 7745 12.3 100440 7350 13.7 65800 5660 11.6 67200 7090 9.5 83570 1052590 NWH 11.2023 NWH 87750 12.2 NWH/G 10.3	¥	84320	7850		83328	7388	11.3	71472	7670	9.3	62992	5035	10.B	A 3700		100
91760 7375 12.4 93000 8130 11.4 61572 6795 9.1 75600 7620 9.9 81220 96250 7640 12:6 97000 7460 13.0 71060 7660 9.4 83823 7575 11.1 80760 9626 91.6 100440 7600 13.2 86970 6900 12.6 83519 7750 10.8 85644 95640 12.3 100440 7585 13.2 82774 7215 11.5 77128 7855 9.8 93487 7515 11.3 100440 7585 13.2 8270 13.4 81390 7060 11.5 91512 8080 11.3 84874 95480 7745 12.3 100440 7350 13.7 6580 13.6 6720 7090 9.5 85350 11.3 84874 95400 7745 12.3 100440 7580 12.8 7560 7840 9.6 85642 6370 13.4 80550 19500 7745 12.3 100440 7580 12.8 7560 7840 9.6 85642 6370 13.4 80550 19500 7745 12.3 100440 7580 12.8 7560 7840 9.6 85642 6370 13.4 80550 19500 7745 12.3 100440 7580 12.8 7560 7840 9.6 85642 6370 13.4 80550 19500 7745 12.3 100440 7580 12.8 7560 7840 9.5 86436 6815 10.7 8640 11.3 86405 7745 12.2 86700 7410 12.1 66950 7190 9.3 86136 6160 14.0 76840 1001 624. 11 120523 84945 GAL 10.3 86436 615 10.8 86436 615 10.8 86436 745 11.3 86436 7	91760 7175 12.4 91000 8130 11.4 61572 6795 9.1 75600 7620 9.9 81220 96250 7640 12:6 97000 7460 13.0 71060 7660 9.4 81923 7575 11.1 80760 96250 7640 12:6 97000 7460 13.0 71060 7660 9.4 81923 7575 11.1 80760 96250 7610 12.3 100440 7585 13.2 82774 7215 11.5 77128 7855 9.8 93487 7761 12.3 100440 7585 13.2 82774 7215 11.5 77128 7855 9.8 93487 7745 12.3 100440 7350 13.7 65800 5660 11.6 67200 7090 9.5 83570 95480 7745 12.3 100440 7350 13.7 65800 5660 11.6 67200 7090 9.5 83570 7680 10.1 97200 7810 10.1 97200 7801 12.8 75600 7840 9.6 85642 6370 13.4 805500 86800 7345 11.8 99720 7650 13.0 7580 6815 10.5 86436 6815 12.7 82478 79200 7735 10.2 MM/G 7350 13.0 75800 7390 9.3 86136 6160 14.0 76840 10.1 97200 740 12.1 66950 7190 9.3 86136 6160 14.0 76840 10.1 97200 7735 10.2 MM/G 12.2 MM/G 12.2 MM/G 12.2 MM/G 12.2 MM/G 12.3 MM/G 51000 9.3 817801 877090 MM 87050 MM 87050 MM 87050 MM 87050 MM 87050 MM 97050 M	dis.	86400	7875		83135	7410	11.2	68480	1300	9.4	61381	7840	7.8	78552		89280
96250 7640 12:6 97000 7460 13.0 71960 7660 9.4 83823 7575 11.11 80760 9660 8455 11.6 100440 7600 13.2 86970 6900 12.6 83519 7750 10.8 85684 95680 7470 12.3 100440 7585 13.2 82774 7215 11.5 77128 7855 9.8 93487 7510 8165 9.3 94080 8220 11.4 81390 7060 11.5 91512 8080 11.3 84874 95480 7745 12.3 100440 7350 13.7 65800 5660 11.6 67200 7090 9.5 83570 9580 7745 12.3 100440 7350 13.7 65800 5600 11.6 67200 7090 9.5 83570 9580 7745 12.3 100440 7350 13.0 71580 6815 10.5 86436 6815 12.7 8248 7735 10.2 90000 7410 12.1 66960 7190 9.3 86136 6815 12.7 8248 7735 10.2 90000 7410 12.1 66960 7190 9.3 86136 6815 12.7 8248 75500 7735 10.2 90000 7410 12.1 66960 7190 9.3 86136 6815 12.7 8248 75500 7735 10.2 90000 7410 12.1 66960 7190 9.3 86136 6815 12.7 8248 75500 7735 10.2 90000 7410 12.1 66960 7190 9.3 86136 6815 12.7 8248 75500 7735 10.2 90000 7410 12.1 66960 7190 9.3 86136 6815 12.7 8248 75500 7735 10.2 87816 7530 7530 7530 7530 7530 7530 7530 7530	96250 7640 12:6 97000 7460 13.0 71960 7660 9.4 83823 7575 11.1 80760 98640 8455 11.6 100440 7600 13.2 86970 6900 12.6 83519 7750 10.8 85684 91760 7470 12.3 100440 7585 13.2 82774 7215 11.5 77128 7855 9.8 93487 75160 8165 9.3 94080 8220 11.4 81390 7060 11.5 91512 8080 11.3 84874 95480 7745 12.3 100440 7580 12.8 75600 11.6 67200 7090 9.5 83570 7745 12.3 100440 7580 12.8 75600 7860 11.6 67200 7090 9.5 86436 6815 12.7 82478 95800 7745 12.3 100440 710 12.1 66960 7190 9.9 86136 6115 11.7 82478 95800 7745 12.2 90000 7410 12.1 66960 7190 9.3 86136 6160 14.0 76841 10 1052590 RMH 1120623 RMH/G 12.2 MM/G 12.3 MM/G 12.2 MM/G 12.3 MM/G 13.3	5	91760	7375		93000	8130	11.4	61572	6795	9.1	75600	7620	0	A1720	•.	
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1052590 KWH 1120623 KW1 847090 KWH 921129 KW1 990455 KWH 10 9206 CAL 100010 CAL 1 10.3 KW1 10 10.8 KW1 10 10.8 KW1 10 10.3 KW1 10 10.8 KW1 10	1052590 KWH 1120623 KWI 877090 KWH 921129 KWI 990455 KWI 10 92125 CAL 84945 CAL 85050 CAL 100010 CAL 11.3 KMI/C 12.2 KMI/C 10.3 KMI/C 10.8 KMI/C 9900455 KMI/C 10.8 KMI/C 990045	3	79200	7735		9000	7410		09699	7190	9.3	86136	6160	14.0	76840		748%
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\$ 15135 \$ 22007 \$ 24827 \$ 29124 <b>\$ 27670 \$</b> I AUXILIARY SITES: FUEL \$4,071,202 (1,961,960 GAL)  LINE OIL \$ 68,982 (118)  PARTS \$ 269,594 (428)  LABOR \$ 300,898 (478)	\$ 15135 \$ 22007 \$ 24827 \$ 29124 \$ 27670 \$  I AUXILIARY SITES: FUEL \$4,071,202 (1,961,960 GAL)  LINE OIL \$ 68,982 (118)  PARTS \$ 269,594 (424)  LABOR \$ 300,898 (473) TOTAL MAINTENANCE: \$639,474	LABOR.	S								~ <b>~</b>						
SITES: FUEL \$4,071,202 (1,961,960 GAL) LINE OIL \$ 68,982 (11%) PARTS \$ 269,594 (42%) LABOR \$ 300,89% (47%)	SITES: FUEL \$4,071,202 (1,961,960 GAL) LIME OIL \$ 68,982 (11%) PARTS \$ 269,594 (42%) LABOR \$ 300,89% (47%) TOTAL MAINTEN	TOTAL	S								<b>√</b> /						
		<b>S</b>	21 AUX IC		ITES:		1111		223	8	960 CM	(7	j				